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# Abstracts

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## Abstracts

K. KURODA and K. SHIMAJI: **Traumatic Resin Canal Formation as a Marker of Xylem Growth**, Forest Sci., **29**, 653 (1983)

Anatomical changes in traumatic resin canal formation induced in *Tsuga sieboldii* by metal pins were examined periodically after insertion. Symptoms of traumatic resin canal formation were first observed in the zone of xylem mother cells within a few days after pinning, and there was a close correlation between these resin canals and the formation of abnormal tissue at the pinned point. Cambial initials at the time of pinning appeared to be in the vicinity of epithelial cells on the cambial side of traumatic resin canals. The validity of using easily discernible, pin-induced traumatic resin canals, instead of minute abnormal tissues, for marking xylem growth is discussed in the light of these findings.

K. YAMAGUCHI, K. SHIMAJI and T. ITOH: **Simultaneous Inhibition and Induction of Compression Wood Formation by Morphaction in Artificially Inclined Stems of Japanese Larch (*Larix leptolepis* GORDON)**, Wood Sci. Technol., **17**, 81 (1983)

Morphaction IT 3456, applied in a 2–3 cm band around the middle portion of 2- or 3-year-old internodes of artificially inclined 5-year-old Japanese larches, induced compression wood formation on both the upper and the lower sides of the inclined stem above the treated region, while it inhibited compression wood formation below this region. These results seem to suggest that a high concentration ratio of endogenous auxin to sugar (auxin/sugar) in the differentiating xylem tissue is necessary and sufficient for compression wood formation, and that compression wood formation under natural conditions requires polar transport of auxin which supplies and maintains high concentration of auxin along the underside of the stem.

K. SHIMAJI, S. HAYASHI and T. ITOH: **On the Tree Species of Excavated Charcoals**, Report on the Excavation of Relics within Taikohyama Land Prefectural Park (1), Educ. Committee of Toyama Pref. ed., 27 (1982) (in Japanese)

43 charcoal samples out of charcoal kilns excavated from Omoteno and Ueno-Akasaka A relics covering 7th–11th centuries in Toyama prefecture were examined for identification of tree species. Each of these samples was identified to be one of the following 11 species covering a wide range of temperate taxa: *Carpinus* sp., *Prunus* sp., *Styrax* sp., *Rhus* sp., *Fraxinus* sp., *Quercus* sp. (Lepidobalanus, Sect. *Prinus*), *Quercus acutissima*, *Castanea crenata*, *Aesculus turbinata*, *Abies firma* and *Cryptomeria japonica*. Among these 11 species, *Carpinus* sp. and *Prunus* sp. were dominant, followed by *Styrax* sp. and *Quercus* sp. There seemed to be no intentional selection of tree species for

charcoal sources.

K. SHIMAJI and S. HAYASHI: **On the Tree Species of Excavated Charcoals**, Report on the Excavation of Relics within Taikohyama Land Prefectural Park (2), Educ. Committee of Toyama Pref. ed., 57 (1983) (in Japanese)

60 charcoal samples out of charcoal kilns excavated from Noda A and Higashiyama II relics covering 7th-11th centuries in Toyama Prefecture were examined for identification of tree species. Each of these samples was identified to be one of the 19 species covering a wide range of temperate taxa: *Cryptomeria japonica*, *Chamaecyparis obtusa*, *Carpinus* sp., *Betula* sp., *Castanea crenata*, *Fagus crenata*, *Quercus* spp. (Lepidobalanus, Sect. Cerris and Prinus), *Ulmus* sp., *Morus australis*, *Magnolia* sp., LAURACEAE, *Prunus* sp., *Ilex* sp., *Acer* sp., *Aesculus turbinata*, *Camellia japonica*, *Eurya japonica* and *Fraxinus* sp. Among these 19 species *Quercus* sp. (Sect. Prinus) and *Castanea crenata* were dominant. There seemed to be no intentional selection of tree species for charcoal source.

K. SHIMAJI and S. HAYASHI: **On the Tree Species of Excavated Charcoals**, Report on the Excavation of Relics along Shichimi-Taikohyama-Takaoka Projected Line, Educ. Committee of Toyama Pref. ed., 68 (1983) (in Japanese)

76 charcoal samples out of charcoal kilns, iron furnaces and dwellings excavated from Omoteno, Minami-Taikohyama II and Higashiyama II relics covering 7th-11th centuries in Toyama Prefecture were examined for identification of tree species. Each of these samples was identified to be one of the following 19 species covering a wide range of temperate taxa: *Chamaecyparis obtusa*, *Carpinus* sp., *Betula* sp., *Castanea crenata*, *Quercus* spp. (Lepidobalanus, Sect. Cerris and Prinus), *Ulmus* sp., *Morus australis*, *Magnolia* sp., LAURACEAE, *Deutzia crenata*, *Prunus* sp., *Rhus javanica*, *Acer* sp., *Aesculus turbinata*, *Camellia japonica*, *Eurya japonica*, *Styrax* sp. and *Fraxinus* sp. Among these 19 species, *Quercus* sp. (Sect. Prinus) and *Castanea crenata* were dominant. These seemed to be no intentional selection of tree species for charcoal source.

T. KOSHIJIMA: **Hemicellulose-Lignin-Conjugate**, Kagaku to Seibutsu, **20** (1), 23 (1982) (in Japanese)

Chemical structure, physical behavior, formation, occurrence of lignin-carbohydrate-complexes in the lignified plants are discussed in connection with their functions in living tissue.

A. ENOKI, F. YAKU and T. KOSHIJIMA: **Synthesis of LCC Model Compounds and Their Chemical and Enzymatic Stabilities**, Holzforschung, **37**, 135 (1983)

Hydrolysis with dioxane-water (1:1) at 180°C for one hour allows to break the phenylglycosidic linkage but remains undegraded at least 85% of the glycosidic bond

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at  $\gamma$ -hydroxyl of lignin side chain. Boron tribromide treatment of all model compounds results in a nearly quantitative splitting of sugar components. The glycosidic bond between carbohydrate and lignin component is hydrolyzed completely by heating with 1 N- $\text{H}_2\text{SO}_4$  at 100°C for 6 hours, but sugar-lignin bond of ether type locating at  $\gamma$ -position of lignin side chain does not undergo acid hydrolysis. Sodium hydroxide (5%) treatment at ambient temperature never cleavage all of the glycosidic bonds synthesized here except compound III, but benzyl ether type locating at  $\alpha$ -position of phenylpropane unit is unstable even for very dilute alkali. It was found that methyl ether of this type compound, VIIIa also suffered alkaline degradation even at near ambient temperature if the prolonged reaction time was employed. Cellulase preparations (Cellulosin AC and AP) hydrolyze quantitatively all of the glycosidic linkages of lignin-carbohydrate synthesized here even though the aglycon is so bulky as dimer of phenylpropane unit. Enzymatic hydrolysis rate is larger in alkylated phenolic hydroxyl in comparison to free phenolic hydroxyl, in the former, benzylated one being more faster than the ethylated. Phenylxyloside is subjected to enzymatic hydrolysis more easily compared with phenylglucoside.

K. INABA, J. AZUMA, Y. IIZUKA and T. KOSHIIJIMA: **Properties of Sulfonated Monosaccharides and Their Acceleration Effect on the Growth of Edible Mushrooms**, Mokuizai Gakkaishi, **29** (9), 621 (1983) (in Japanese)

The effects of calcium salts of D-glucose, D-mannose, and D-xylose on the growth of mycelia of *Lentinus edodes*, *Pleurotus ostreatus*, and *Flammulina velutipes* were investigated. Each monosaccharide had been sulfonated with 4% sodium sulfite-11% sodium hydrogen sulfite solution (pH 6.0) at 135°C for various periods up to eight hours, each monosaccharide being sulfonated with the loss of its reducing ability during, that time. Monosaccharide sulfonates thus obtained were added to a potato medium as a carbon source (1%). The growth of mycelia was accelerated prominently only in the cases of glucose and xylose sulfonates with a reaction time of six hours. The yields of mycelia of *L. edodes*, *P. ostreatus*, and *F. velutipes* were 2.2-, 1.8-, and 1.2-folds higher than those cultured without sugar sulfonates. Glucose and xylose sulfonates with the other reaction times, and all mannose sulfonates, gave only a little or no increase of mycelia.

E. MAEKAWA and T. KOSHIIJIMA: **Woods Polysaccharides Dissolved in the Liquor in the Process of Preparing Holocellulose by Using Peracetic Acid**, Mokuizai Gakkaishi, **29** (6), 415 (1983) (in Japanese)

The amount and composition of wood polysaccharides dissolved in the liquor during the preparation of holocellulose by the peracetic-acid method were investigated and characterized in comparison with Wise's chlorite method. After delignification, wood polysaccharides dissolved in the liquor were isolated and analyzed according to

to the procedure described in the previous paper.

The results are summarized as follows:

- 1) The amounts of the carbohydrate components dissolved in liquor during the preparation of holocellulose by the peracetic-acid method are indicated quantitatively. The amounts of carbohydrate lost through dissolution were 3% for Buna, 4% for Akamatsu and 2% for Take, based on wood meal.
- 2) Carbohydrate components of softwood such as Akamatsu are apt to be lost through dissolution into the liquor with the progress of delignification during the preparation of holocellulose, although softwoods are difficult to delignify in comparison with the hardwoods.
- 3) Analysis of the polysaccharide components dissolved in liquor upon delignification indicated the presence of unusual amounts of glucan. The glucan was attributed to starch in Take and Buna, but for Akamatsu it was assumed to be attributable to glucomannan.
- 4) UV (Ultra-Violet) absorption near 280 nm, originating from a benzene nucleus, was still observed in the oxidized lignin-fraction even after the delignification treatment with acid chlorite, but upon treatment with peracetic acid the degradation of the benzene nucleus was confirmed by the disappearance of the UV absorption near 280 nm.

E. MAEKAWA and T. KOSHIJIMA: **Evaluation of the Acid-chlorite Method for the Determination of Wood Holocellulose**, *Mokuzai Gakkaishi*, **29** (10), 547 (1983) (in Japanese)

An evaluation of the acid-chlorite method for the determination of wood holocellulose was made by an examination of the mutual relationship between the delignification process and the amounts of polysaccharide components dissolved into liquor after delignification. Based on results, it was concluded that the use of an acetate buffer-solution as a reaction medium on the acid-chlorite treatment may contribute to promoting the delignification process and reducing the loss of carbohydrate into liquor. Consequently, this modified acid-chlorite method using an acetate buffer-solution of 0.2–0.5 M as a reaction medium is presented as an improved method for preparing wood holocelluloses.

E. MAEKAWA: **Dialdehyde Cellulose Derivatives and Their Application derived from Cellulose**, *New Lumberman*, **13** (47), 10 (1983) (in Japanese)

The brief explanation on some derivatives and their application of dialdehyde cellulose obtained by periodate oxidation of cellulose was made.

F. TANAKA and T. KOSHIJIMA: **Measurement of the Three-Dimensional Orientation Distribution of Cellulose Crystallites in *Pinus densiflora* Wood**, *Mokuzai Gakkaishi*, **29** (1), 1 (1983)

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From the investigation of the three-dimensional orientation distribution of cellulose crystallites by the pole-figure method, it was proven that the crystallites of woods has nearly a uniaxial orientation in normal wood and a biaxial orientation in compression wood. Not only the fibrillar angles but also the three-dimensional orientation distributions of cellulose crystallites in woods were different among their different kinds of tissue. It was difficult to directly correlate these observations with the so-called "planar-orientation" concept.

F. TANAKA and T. KOSHIJIMA: **Measurements of Three Dimensional Orientation Distributions of Cellulose Crystallites in *Pinus densiflora* Woods**, ISWPC Proceedings, Vol. 1, p. 35 (1983)

Three-dimensional orientation distributions for cellulose crystallites in *Pinus densiflora* opposite, normal and compression woods were quantitatively evaluated through the discription of pole figures for (101), (10 $\bar{1}$ ), (002) and (040) planes of cellulose crystallites in their woods. Some fine differences were found between orientation distributions of cellulose crystallites in their wood except the difference of their fibrillar angles. It was also found that the orientation distribution functions of cellulose crystallites in their woods against the orientation angle  $\phi$  were independent from those against the angle  $\psi$ . The orientation distribution function of cellulose crystallites in wood was also found to be a general function. We also showed that the orientation factors were able to explain the relationship between wood anatomy and the anisotropic bulk properties of wood quantitatively.

A. KATO, J. AZUMA and T. KOSHIJIMA: **A New Feruloylated Trisaccharide from Bagasse**, Chem. Lett., 137 (1983)

*O*-(5-*O*-Feruloyl- $\alpha$ -L-arabinofuranosyl)-(1 $\rightarrow$ 3)-*O*- $\beta$ -D-xylo-pyranosyl-(1 $\rightarrow$ 4)-D-xylopyranose was isolated from the enzymatic hydrolysate of bagasse lignin-carbohydrate complex containing ferulic acid (LCC-F) and identified from I.R., U.V., G.L.C.-M.S., and N.M.R. spectra.

J. SUZUKI, J. AZUMA, T. KOSHIJIMA, K. OKAMURA and H. OKAMOTO: **Characterization of Mono-and Oligosaccharides Produced by CO<sub>2</sub> Laser Irradiation on in Cellulose**, Chem. Lett., 481 (1983)

The chemical structures of three mono-, two di-, and two tri-saccharides isolated from the pyrolysis products formed by CO<sub>2</sub> laser irradiation on cellulose were investigated.

J. ASUMA and T. KOSHIJIMA: **Hydrolysis of Wood Polysaccharides by Enzyme System**, Wood Research and Technical Notes, 17, 1 (1983)

Recent studies on enzymatic saccharification of woody plants were reviewed and

discussed.

J. AZUMA and T. KOSHIJIMA: **<sup>13</sup>C-NMR Spectroscopy of Carbohydrates II. <sup>13</sup>C-NMR Spectroscopy of Xylan and Related Carbohydrate**, Wood Research and Technical Notes, **17**, 132 (1983)

<sup>13</sup>C-NMR spectroscopic data of xylan and related carbohydrates were summarized and utilisation of <sup>13</sup>C-NMR for structural analysis of xylan and xylan like carbohydrates were also reviewed.

S. IWAHARA and T. HIGUCHI: **Enzymic Oxidation of *d,l*-Syringaresinol**, Agric. Biol. Chem., **46**, 2143 (1982)

This paper reports the identification of the reaction products from *d,l*-syringaresinol with an inducible enzyme of *Fusarium* sp. M 4-2.

H. KUTSUKI and T. HIGUCHI: **Activities of Some Enzymes of Lignin Formation in Reaction Wood of *Thuja orientalis* and *Metasequoia glyptostroboides*** 2, Wood Sci. Technol., **16**, 287 (1982)

To elucidate biochemical features leading to p-hydroxyphenyl-rich lignin in gymnosperm reaction wood the activities of the following five enzymes involved in the biosynthesis of p-hydroxyphenyl lignin were compared in reaction and opposite woods: phenylalanine ammonialyase (EC 4.3.1.5), cinnamate 4-hydroxylase (EC 1.14.13.11), p-hydroxycinnamate: CoA ligase (EC.6.2.1.12), cinnamyl alcohol dehydrogenase (EC 1.1.1.-) and peroxidase (EC 1.11.1.7). The enzyme activities in the reaction woods of *Thuja orientalis* and *Metasequoia glyptostroboides* were remarkably higher than those in the opposite woods, reflecting the higher contents of p-hydroxyphenyl lignin in reaction wood.

T. HIGUCHI: **Biosynthesis and Microbial Degradation of Lignin**, In "The New Frontiers in Plant Biochemistry", eds., T. Akazawa, T. Asahi and H. Imaseki, pp. 23-46, Japan Scientific Societies Press (1983)

Recent investigations on biosynthesis and microbial degradation of lignin were reviewed.

T. HIGUCHI: **Biosynthesis, Biodegradation**, In "Wood Chemistry", eds., J. NAKANO, T. HIGUCHI, M. SUMIMOTO and A. ISHIZU, pp. 345-416 (in Japanese), Uni Publishing Co. (1983)

Recent investigations on biosynthesis and microbial degradation of lignin were reviewed.

T. UMEZAWA, F. NAKATSUBO and T. HIGUCHI: **Degradation Pathway of Aryl-glycerol- $\beta$ -aryl Ethers by *Phanerochaete chrysosporium***, Agric. Biol. Chem., **47**, 2677 (1983)

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The degradation pathway for the most important  $\beta$ -O-4 lignin substructure with a white rot fungus, *Phanerochaete chrysosporium*, was investigated, and the following conclusions were obtained. a) The allyl alcohol end group attached to the  $\beta$ -O-4 substructure was degraded to a formyl group *via* a glycerol group. b) Arylglycerol was formed by the cleavage of the  $\beta$ -O-4 substructure without involvement of the hydroxylation reaction at C $_{\beta}$ . c)  $^{18}\text{O}$  was not incorporated from  $^{18}\text{O}_2$  into arylglycerol nor phenol liberated by the degradation of the  $\beta$ -O-4 substructure, but was incorporated into the benzyl alcohol derivative formed by C $_{\alpha}$ -C $_{\beta}$  cleavage. d) Two alternative degradation pathways of the  $\beta$ -O-4 substructure, a pathway *via* arylglycerol and direct oxygenative C $_{\alpha}$ -C $_{\beta}$  cleavage, are proposed.

Y. KAMAYA, F. NAKATSUBO and T. HIGUCHI: **Degradation of Trimeric Lignin Model Compounds, Arylglycerol- $\beta$ -syringaresinol Ethers, by *Fusarium solani* M-13-1**, Agric. Biol. Chem., **47**, 299 (1983)

Trimeric lignin model compounds, arylglycerol- $\beta$ -syringaresinol ethers, were incubated with *Fusarium solani* M-13-1 in basal salts medium with shaking. From the culture filtrates, degradation products were isolated and characterized spectroscopically. Based on the degradation products of guaiacylglycerol- $\beta$ -syringaresinol ether (II), the following reactions were found to occur; 1) oxidation of benzylic position ( $\alpha''$ ) and subsequent ring opening of the syringaresinol side chain, 2) cleavage of alkyl-aryl C-C bonds (C $_x$ -C $_1$  and C $_x''$ -C $_1''$ ) of both arylglycerol and syringaresinol portions, and 3) splitting of the alkyl-aryl ether bond (C $_{\beta}$ -O-C $_4'$ ). In the case of syringylglycerol- $\beta$ -syringaresinol ether (III), preferential oxidation of benzylic position ( $\alpha$ ) of the arylglycerol moiety was seen. The former two reactions were found to be catalyzed by the fungal phenol oxidizing enzymes.

T. HIGUCHI, H-m. CHANG, and T.K. KIRK: **Recent Advances in Lignin Biodegradation Research**, Uni Publishers Co. Ltd. Chuo-ku, Tokyo, 103, Japan pp. 1-279 (1983)

Proceedings of an international seminar on lignin biodegradation, organized under the auspices of US-Japan Cooperative Science Program, held on May 31-June-2, 1983, in Kyoto, Japan.

T. HIGUCHI, F. NAKATSUBO, Y. KAMAYA, and T. UMEZAWA: **Mechanism of  $\beta$ -Aryl Ether Cleavage by *Phanerochaete chrysosporium*, and the Role of Peroxidase in Lignin Biodegradation**, In, "Recent Advances in Lignin Biodegradation Research", eds., T. HIGUCHI, H-m. CHANG, and T.K. KIRK (Uni Publishers, Tokyo), p. 209 (1983)

Degradation pathways of important dilignols, including guaiacylglycerol- $\beta$ -coniferyl ether, dehydrodiconiferyl alcohol, *d,l*-pinoresinol, and diguaiacylpropane-1,



3-diol, by *Phanerochaete chrysosporium*, and *Fusarium solani* M-13-1 were elucidated. The results indicate that both fungi cleave side chains of phenolic dilignols between C<sub>α</sub> and C-1 (aromatic ring carbon) to derive methoxybenzoquinones. A similar degradation pathway was found in the degradation of a trilignol, guaiacylglycerol-β-syringaresinol ether. The side chains of methylated non-phenolic dilignols are generally cleaved between C<sub>α</sub> and C<sub>β</sub> by *Phanerochaete* to give veratric acid from non-condensed aromatic rings, and 5-carboxyveratric acid from condensed aromatic rings. In the degradation of non-phenolic β-aryl ether models by *Phanerochaete*, two pathways are proposed: one producing arylglycerol, and phenol originating from the β-ether, and the second direct oxygenative C<sub>α</sub>-C<sub>β</sub> cleavage of the β-O-4 substructure producing aromatic aldehyde and a C2 fragment with the β-linked phenol. The role of peroxidase in the degradation of phenolic dilignols is discussed in relation to lignin biodegradation.

M. SHIMADA, and T. HIGUCHI: **Biochemical Aspects of the Secondary Metabolism of Xenobiotic Lignin and Veratryl Alcohol Biosynthesis in *Phanerochaete chrysosporium***, In, "Recent Advances in Lignin Biodegradation Research", eds., T. HIGUCHI, H-m. CHANG, and T.K. KIRK (Uni Publishers, Tokyo), p. 195 (1983)

By use of various radical scavengers and cytochrome P-450 inhibitors, their inhibitory effects on lignin biodegradation and veratryl alcohol biosynthesis were studied. The inhibitory effects observed with tyrosine-copper complex (TCC) suggest that cytochrome P-450 might be involved in both metabolic processes. In addition, β-ether cleavage of a β-O-4 dilignol and demethylation of veratric acid were potently inhibited by TCC, whereas decomposition of glucose-U-C-14 to CO<sub>2</sub> and vanillate decarboxylation were not inhibited significantly. After cell-free extraction of the fungal culture grown under different conditions, peroxidase activity which might be alternative expression of cytochrome P-450 monooxygenase was examined. The enzyme activity was greatly enhanced by 100% O<sub>2</sub>. The enzyme was significantly activated by phenobarbital as a common xenobiotic inducer for cytochrome P-450 electron transport system, and also by ethylene. However, it was almost completely inactivated by incubation of the ligninolytic cultures with 2.5 mM L-glutamate for 12 hrs. Extracellular and membrane-bound enzyme fractions obtained from the ligninolytic cultures were shown to produce ethylene from KTBA in the presence of H<sub>2</sub>O<sub>2</sub>. For comparison, the cytochrome P-450 electron transport system from *Pseudomonas putida* was also shown to produce ethylene from KTBA in the presence of NAD(P)H and O<sub>2</sub>, or H<sub>2</sub>O<sub>2</sub>. These results strongly indicate that an NADPH/O<sub>2</sub>-requiring cytochrome P-450 electron transport system may be a regulatory key enzyme system shared by both lignin biodegradation and veratryl alcohol metabolism.

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M. SHIMADA and M.H. GOLD: **Direct Cleavage of the Vicinal Diol Linkage of the Lignin Model Compound Dihydroanisoin by the Basidiomycete *Phanerochaete chrysosporium***, Arch. Microbiol., **134**, 299 (1983)

The white rot basidiomycete *Phanerochaete chrysosporium* metabolized dihydroanisoin (1,2-dianisylethane-1,2 diol) in low nitrogen stationary cultures, conditions under which the ligninolytic system is expressed. Anisyl alcohol was isolated as a metabolic product indicating an initial diol bond cleavage of the substrate. Use of  $^3\text{H}$ -labeled dihydroanisoin (1,2-dianisylethane-1,2-diol-1,2  $^3\text{H}$ ) indicated that the diol bond was cleaved directly, yielding anisyl aldehyde as the initial product. The metabolically stable ketol anisoin was shown not be an intermediate in the metabolism of dihydroanisoin. The diol cleavage reaction was dependent on the concentration of molecular oxygen but  $\text{O}_2$  could be replaced by  $\text{H}_2\text{O}_2$  under some conditions. The cleavage reaction was inhibited by exogenously-added tyrosine $_2$ - $\text{Cu}^{2+}$  complex (TCC). The appearance of the fungal diol cleavage system parallels the appearance of the ligninolytic system under a variety of physiological conditions. In addition, preincubation of ligninolytic cultures with 2.5 mM L-glutamate represses both the ligninolytic and the diol cleavage activities.

M. SHIMADA: **Xenobiotic Lignin Biodegradation; A Possible Tangent of Secondary Metabolism of White-Rot Fungi with Cytochrome P-450** (Review, in Japanese), Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. **17**, 21 (1983)

Importance of lignin biodegradation research was reviewed on the following points: a) Possible participations in lignin biodegradation of the active oxygen species and cytochrome P-450 as a key enzyme with nonstereospecificity. b) Roles of secondary metabolism of L-phenylalanine in biosynthesis of veratryl alcohol in white-rot fungi. c) Perspective views for utilization of ligninolytic biocatalyst.

A. SATO: **Short Report about the Logwood for Black Dyeing**, Mokuzai Kogyo (Wood Industry), **37**, 609 (1982) (in Japanese)

The author reported about his survey trip for Mexico in 1981. In this report, the story of logwood (*Haematoxylon campechianum*) was divided to several sections as following; a plant, wood, chemical properties and trading history so on.

A. SATO, J. AZUMA, S. KUMAGAWA and Y. KAWAMURA: **Production of Logwood Extracts in Japan**, 1983 International Symposium on Wood and Pulping Chemistry, Poster Session, May 23-27 (1983) at Tsukuba (Japan)

Logwood and its extracts are necessary to make a traditional kimono, Kurotomesode, which dyes black through the technique of Kurozome (black dyeing). After the lack of imported material last decade, a Japanese Wood Company tried

to produce the extracts using imported wood, and the extracts are sold successfully in liquid. This wood was also analysed chemically, and xylose was the most abundant in the components of carbohydrates. Major coloring compound, hematoxylin, is probably contained as a xyloside.

A. SATO and T. YOSHIMOTO: **Chemistry of Wood Utilization with Lists of Wood Extractives and pH values on Wood Sap**, Edited by H. Imamura et al, Kyoritsu Press Ltd. Co. (1983), Tokyo

In Chapter 14, which is titled a Utilization and Chemical Constituents of Barks, utilization for fuels, glazes and medicines from barks are described by the author. Destruction of refractory bricks are especially illustrated with analytical data of the ashes about tropical woods and their barks.

M. TANAHASHI, T. AOKI and T. HIGUCHI: **Dehydrogenative Polymerization of Monolignols by Peroxidase and  $H_2O_2$  in a Dialysis Tube. II. Estimation of Molecular Weights by Thermal Softening Method**, *Holzforschung*, **36**, 117 (1982)

Thermal softening was measured to determine the molecular weight and the molecular weight distribution of the insoluble lignins. The thermal softening temperature ( $T_s$ ) of DHP prepared by dialysis membrane method (175°C) was higher than those of bamboo MWL (162°C), Zutropfverfahren DHP (162°C) and Zulaufverfahren DHP (134°C). The results indicated that the DHP by dialysis membrane method has a higher molecular weight and a higher degree of cross-linked structure than MWL and other DHPs.

M. TANAHASHI and T. HIGUCHI: **Possible Formation of L.C.C. via Quinone-methide Intermediates of Lignols**, Canadian Wood Chemistry Symposium (Niagara Falls), **1**, 67 (1982)

The formation of ether and ester linkages between sugars and quinonemethides from guaiacylglycerol- $\beta$ -guaiacyl ether (I) and from isoeugenol (II) was investigated. Hexoses and pentoses were linked to the quinonemethide from I *via* C6 and C5 primary hydroxyl groups respectively to form guaiacylglycerol- $\alpha$ -D-sugar- $\beta$ -guaiacyl-di-ethers. The results suggested that L.C.C. could be formed by the addition of primary hydroxyl- and carboxyl groups of sugar residues of hemicelluloses to the quinonemethide intermediates of lignols during lignification.

M. TANAHASHI: **Steam Explosion Process — Pretreatment of Lignocellulose for Enzymic Saccharification and Ruminant Feed Preparation**, Biomass and Biotechnology '83, Nippon Noritsu Kyokai, **4**, 1 (1982) (in Japanese)

To accomplish economically feasible delignification processes of wood for enzymic

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saccharification and ruminant feed preparation explosion wood process has been investigated. Wood chips of Shirakanba (*Betula platyphylla* var. *japonica*) and Karamatsu (*Larix leptolepis*) were treated with a high pressure steam (12–28 kg/cm<sup>2</sup>) for 1–16 min., and the steam pressure was released instantaneously to result in explosion wood (EXW). Shirakaba chips were fibrillated to a soft mass, whereas Karamatsu chips gave small nonfibrillated block fragments. Glycosidic linkages of hemicelluloses and alkyl-aryl linkages of lignin were hydrolyzed to give low molecular weight fragments. Cellulose, on the other hand, remained apparently intact, and the crystallinity and micelle width were increased by the explosion. EXWs were easily hydrolyzed by cellulase and digested by ruminants: saccharification, over 90% and *in vitro* and *in vivo* digestibilities, 80–90%.

Y. TOGAMURA, A. MIYAZAKI, R. KAWASHIMA, T. HIGUCHI, M. TANAHASHI and K. KIYOTOU: **Effects of Explosion Treatment on Chemical Composition and *in vitro* Digestibility of Rice Straw and Hulls**, Japanese J. Zootechnical Science, **54**, 206 (1982) (in Japanese)

This experiment was conducted to study the effect of an explosion treatment on the nutritive value of rice straw and hull, which are abundant by-products of rice culture in Japan. In this explosion treatment, chopped straw and hull were kept at a high pressure of 22.5 kg/cm<sup>2</sup> with steam for 2 minutes respectively, and released quickly from the pressure to be exploded. While the contents of crude protein, ether extract, crude ash, cellulose and lignin did not show any remarkable changes by the explosion treatment, cell wall constituents and hemicellulose decreased from 60.9, 19.6% to 56.8, 9.9% in straw, and from 79.5, 22.6% to 67.3, 13.1% in hull. Substances dissolved into synthetic saliva solution increased by the explosion treatment. *In vitro* digestibilities of organic matter and organic cell wall constituents increased by the explosion from 43.7, 20.9% to 75.0, 64.2% in straw, and from 5.4, 0.7% to 25.7, 7.6% in hull. Fresh exploded sample seemed to have a slightly higher digestibility than air-dried one. The explosion treatment longer than 2 minutes did not show any additional improvement in *in vitro* digestibilities of organic matter and organic cell wall constituents of straw. *In vivo* digestibilities of dry matter, organic matter, crude fiber and cell wall by wethers were improved through the explosion treatment significantly ( $P < 0.1$ ), though digestibility of crude protein decreased significantly ( $P < .01$ ). Especially digestibility of crude fiber was remarkably improved by the treatment from 34.3% to 75.9%. From the results of this experiment, it is supposed that the explosion treatment is an effective method to improve the nutritive value of rice straw and hull.

A.P. SCHNIEWIND, T. OHGAMA, T. AOKI and T. YAMADA: **Effect of Specific Gravity, Moisture Content, and Temperature on Fracture Toughness of**

**Wood**, Wood Sci., **15**, 101 (1982)

The objective of this study was to examine fracture toughness in relation to temperature, moisture content (MC), and specific gravity. Published values for the strain energy release rate of wood ( $G_{Ic}$ ) increase with increasing MC and temperature. It was found that when these data are converted to critical stress intensity factors ( $K_{Ic}$ ) their relationship to MC and temperature is more complex. At high MCs,  $K_{Ic}$  values decrease with increasing temperature. This was confirmed on tests of  $K_{Ic}$  in the TR system of three Japanese species—sugi, hinoki, and buna—by tests at 20°, 40°, and 60°C and MCs of 15 and >30 percent. At constant temperature, calculated  $K_{Ic}$  values reach a maximum at an MC between the fiber saturation point and the oven-dry condition. Tests of five softwood and nine hardwood species ranging in specific gravity from 0.15 to 0.72 were made in both the TL and the LT systems at nominal 12 percent MC. In both cases, a close correlation of  $K_{Ic}$  with specific gravity was found, with coefficients of determination ( $R^2$ ) ranging from 0.76 to 0.85.

N. SHIRAISHI, T. AOKI, M. NORIMOTO and M. OKUMURA: **Make Cellulosics Thermoplastic**, CHEMTECH, **13**, 366 (1983)

Can wood melt? Our answer is a qualified yes. But one must first perform simple chemical modifications. Homogeneous grafting using an organic cellulose solvent as a reaction medium allows cellulose to melt when heated, while heterogeneous graftings that we have examined do not. When thermally unmeltable, acetylated wood is chemically modified by grafting, one can achieve melting even by low graft add-ons. Such products can be molded under pressures to form transparent sheets in equipment usually used for compression molding.

T. ONO and M. NORIMOTO: **Study on Young's Modulus and Internal Friction of Wood in Relation to the Evaluation of Wood for Musical Instruments**, Japanese J. Appl. Phys., **22**, 611 (1983)

Young's modulus  $E$  and internal friction  $Q^{-1}$  in longitudinal ( $L$ ) direction and specific gravity  $\gamma$  were measured for numerous specimens of 25 softwood species. There was a high correlation between  $Q^{-1}/(E/\gamma)$  and  $E/\gamma$ , and the suitability of wood for musical instruments can be evaluated by using the value of  $E/\gamma$ . Furthermore, effects of grain angle in the longitudinal-radial plane on Young's modulus and internal friction of wood were investigated. From these results, it is concluded that the value of internal friction as well as Young's modulus of wood is determined in large part by microfibril angle in the  $S_2$  layer of tracheid against the  $L$  direction.

M. MORI, M. NORIMOTO and Y. WAKITA: **Surface Temperatures of Pieces of Bamboo, Rattan and Wood during Microwave Irradiation**, Mokuzai Kogyo, **38**, 229 (1983)

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Surface temperatures of pieces of two kinds of bamboo, rattan and wood were measured during microwave irradiation by a non-contact infra-red thermometer, and compared with the glass transition temperatures of their chemical constituents.

When microwaves were irradiated on water-saturated pieces of bamboo, rattan and wood, their surface temperatures rose to 140–150°C, 100°C and 90–110°C, respectively, which exceeded the glass transition temperatures of lignin and hemicelluloses in a wet condition.

When their cross sections of bamboo and rattan were sealed with polyurethane resin, surface temperatures were higher than when unsealed. This was caused by the higher water vapor pressure in the sealed pieces.

It is considered that thermal processing utilizing microwave heating is the most effective for bamboo, whose surface temperature was the highest of the three during microwave irradiation.

T. AOKI and M. NORIMOTO: **Wood Bending Utilizing Microwave Heating, Changes in Curvature of Bentwood due to Moisture Change**, Wood Research and Technical Notes, No. 17, 88 (1983).

After water-saturated wood pieces were irradiated with microwaves, they were bent to various radii of curvature  $R_0$  and dried under restraint. They contracted on the concave side and elongated on the convex side. If the fixed strains on the extreme inner and outer surfaces of a bent piece were denoted by  $\epsilon_1$  and  $\epsilon_0$ , respectively, the relationship between them was expressed by  $\epsilon_1 = -2\epsilon_0$ . The radius of bend  $R$  changed when the bent piece was subjected to moisture change. An increase in moisture content caused the radius to increase owing to the recovery of the fixed strains. Similarly a decrease caused the radius to decrease since the shrinkages of the bent piece occurred during drying and in such a case the shrinkages on the concave side were two times larger than those on the convex side. The increment of the chord  $2X$  shown in Fig. 4 for the bent piece per unit increase in moisture content,  $A$ , was almost the same among different wood species compared at the same  $R_0$ . There was a linear relationship in logarithmic scales between  $A$  and  $R_0$ .

I. IDA and M. NORIMOTO: **Wood Bending Utilizing Microwave Heating, Hygrothermal Recovery of Bentwood in the Direction Perpendicular to Grain**, Wood Research and Technical Notes, No. 17, 99 (1983)

Wood pieces were bent in the direction perpendicular to grain during microwave irradiation and changes occurred in the anatomical structure of the bent pieces were examined through SEM observation. Furthermore, changes in curvature of the bent piece by moisture and heat treatments were investigated. Cells on the convex and concave sides of the bent piece were extremely extended and contracted to the direc-

tions of induced tensile and compressive stresses, respectively. Irregularities of the wall surface and distorted pit apertures were found on the radial walls on the concave side. The bent pieces returned almost to their original shapes when they were subjected to moisture and heat treatments. However, the extent of the recoveries by the respective treatments was different between hardwoods and softwoods. One of the causes seemed to be resulted from the different proportions in the chemical constituents. By such treatments the irregularities of the wall surface were disappeared and the distorted cells returned to their original shapes.

K. SUMIYA: **Junction of Wood Formation and Biotechnology**, Wood Research and Technical Notes, No. 17, 54 (1983)

The present subjects in the application of genetic engineering to wood are reviewed. The most difficult process is the gene conversion. The alternative processes would be gene mutation and cell fusion. The methods to the regeneration of plantlet from tissue culture should be investigated too. The mass production of useful mutants might be controlled well in a factory.

M. NORIMOTO, T. MOROOKA, Y. AOKI, N. SHIRAISHI, T. YAMADA and F. TANAKA: **Some Physical Properties of Benzylated Wood**, Wood Research and Technical Notes, No. 17, 181 (1983)

Physical properties of benzylated wood were discussed through the results of IR spectra, x-ray diffraction, thermal softening, stress-strain relationship, temperature dependence of dynamic Young's, modulus and loss, and temperature and frequency dependence of dielectric constant and loss.

M. NORIMOTO: **Woodbending**, Polymer Applications, **32**, 136 (1983)

Wood bending utilizing microwave heating were reviewed and discussed.

T. MOROOKA, M. NORIMOTO, T. YAMADA and N. SHIRAISHI: **Viscoelastic Properties of (Cellulose Oligo-Oxymethylene Ether) Acylates**, J. Appl. Polym. Sci., **27**, 4409 (1982)

Four kinds of (cellulose oligo-oxymethylene ether) acylates from the acetate to the valerate were prepared by homogeneous reactions using a DMSO/PF cellulose solvent as the reaction medium. The temperature variations of dynamic modulus, loss modulus, and loss tangent for these polymers were measured. Three types of relaxation process were observed for all (cellulose oligo-oxymethylene ether) acylates, and an additional relaxation process was detected for (cellulose oligo-oxymethylene ether) butyrate and valerate. These processes were labelled  $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$  in order of decreasing temperature at which they occurred. These  $\alpha$  to  $\delta$  processes were respectively attributed to micro-Brownian motion ( $\alpha$ ), motion of side chains ( $\beta$ ), local mode motion

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involving oxymethylene groups ( $\gamma$ ), and motion initiated by three or more methylene groups ( $\delta$ ).

T. MOROOKA, M. NORIMOTO, T. YAMADA and N. SHIRAISHI: **Compatibility of Polymer Blend of Caprated Wood with Polyethylene, Nylon or Polyester**, Wood Research and Technical Notes, No. 17, 75 (1983)

Mechanical relaxation processes occurring in caprated wood were assigned and compatibility of caprated wood with a few synthetic polymers was investigated.

Three types of relaxation process were observed in loss tangent versus temperature curve for caprated wood film. These processes were labelled  $\alpha_{cw}$ ,  $\beta_{cw}$ , and  $\gamma_{cw}$  in order of decreasing temperature at which they occurred. These  $\alpha_{cw}$  to  $\gamma_{cw}$  processes were, respectively, attributed to; micro-Brownian motion of main chain ( $\alpha_{cw}$ ), motion of side chain ( $\beta_{cw}$ ) and motion initiated by three or more methylene groups ( $\gamma_{cw}$ ). The caprated wood film underwent a high degree of elongation of 90% prior to failure in tensile test at room temperature.

Blends of caprated wood with polyethylene, nylon or polyester showed two-phase systems. In such a case, however, some differences in compatibility among these blends were recognized. The ultimate elongation of the film was the best criterion for detecting the differences in compatibility. Blends of caprated wood with polyester were the best of the three.

T. YAMADA and S. KATO: **Physical Aspects of Science of Woody Resources, Supplement**, Wood Research and Technical Notes, No. 17, 170 (1983)

The two appendices are; major characteristics of the wood industry in Japan; utilization of short rotation trees.

H. SASAKI, S. KATO and T. TANOUCHI: **Development of a Veneer Lathe with Powered Backup Rolls and Its Application to LVL Plants for Small Logs from the Thinning Operation**, Mokuzai Kogyo (Wood Industry), 38, (10), 23 (1983) (in Japanese)

A new type veneer lathe with three powered backup rolls was developed by the authors in order to get high yield for peeling logs with small diameter. The capacity and mechanism of the rolls are explained.

Mechanical properties of 10-ply LVL made of 4 mm thick veneers which are peeled from Japanese cedar or cypress thinnings by this new lathe are shown.

Essential points for designing LVL plants for domestic softwood thinnings are clarified.

Economical discussions are made on a plant designed on a model case including the above mentioned new lathe and a radio frequency heating press.



H. SASAKI, K. SUMIYA, S.P. TAKINO: **Mechanical Properties of Thirty-Six Varieties of Cryptomeria**, Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 17, 192 (1983) (in Japanese)

A log 20 years old of each 36 varieties of Cryptomeria (Japanese cedar) which are collected from Honshu, Shikoku and Kyushu Islands and planted on an experimental forest in Kumamoto Prefecture, Kyushu, was cut into  $80 \times 80$  or  $95 \times 95$  mm in cross section and 1,900 mm long.

Bending strength of these 36 specimens is roughly proportional to the density, while the Young's modulus in bending varies widely. A group of the varieties has extremely low modulus and all of the load-deflexion curves observed on the group showed extremely large plastic deformation.

The same characteristics are observed on clear small specimens cut from the end parts of the above bending specimens.

T. HAYASHI and H. SASAKI: **Fatigue Properties of Nailed Wood-Metal Joints**, Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 17, 112 (1983) (in Japanese)

Repetitive loading (fatigue), constant loading (creep) and ramp loading tests in tension were made on the butt-jointed  $2'' \times 4''$  sized spruce specimens with two flat metal plates ( $1.2 \times 40 \times 90$  mm) nailed on both surfaces of the specimen with four common nails (ZN40) each.

Performance of the joints under these three different types of loading was discussed on the relative displacement (opening of the butt-joint). The results are summarized as follows:

- 1) The fatigue limit of the joints for repetitive load is estimated at 23% of the static strength.
- 2) Failure of the joint is generally characterized by withdrawal of nails, while by fatigue of nails for repetition of low level of loading.
- 3) Repetition of load seems to have little effect on the residual strength of the joint.
- 4) The ultimate strength of the joints increases with increasing rate of ramp loading.
- 5) The opening of the joints is remarkable when load more than 50% level of static strength is applied.

T. HAYASHI, H. SASAKI and T. FUYUKI: **Effect of Butt-Joint Gap on Fatigue Properties of LVL Joints with Metal Plate Connectors**, Mokuzai Gakkaishi, 29 (10), 663 (1983) (in Japanese)

Pulsating (tension) and reversely (tension and compression) repeated loads were applied to 14-ply, 40 mm thick, larch LVL butt-jointed with metal plate connectors including joint gap of clearance 0–1 mm, and the effects of clearance of gap on fatigue

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properties of the joint were discussed.

The clearance of the joint gap has little effects on both static tensile strength and fatigue strength under pulsating load. However, evident effects appear on fatigue strength under reversely repeated load.

For instance, the fatigue life of joints with gap clearance of 1.0 mm is 1/10 of that with no clearance.

M. TAKATANI, R. HAMADA and H. SASAKI: **Cleavage Fatigue Strength of Wood-Epoxy Bond System**, Zairyo (J. Soc. of Material Science, Japan), **32** (359) 916 (1983) (in Japanese)

Cleavage fatigue tests were carried out on double cantilever beam type specimens bonded with epoxy resin adhesives mixed with different amount of flexibilizer (poly-sulfide). The results are as follows:

- 1) Cleavage fatigue strength decreased with increasing flexibility of glue-line, while the static strength increased effectively with it.
- 2) Both fatigue and static strength increased with increasing glue-line thickness, which effect was remarkable with the latter.
- 3) Fatigue limit of all bonded specimens was lower than that of solid wood specimens while the static strength of specimens bonded with epoxy resin mixed with 40 or 60 parts of plexibilizer was exceeded that of solid wood specimen.

M. TAKATANI, R. HAMADA and H. SASAKI: **Bending Fatigue Strength of Epoxy Resin Bond System II-Fatigue tests under wet condition**, Setchaku Kyokaishi (J. Japan Soc. Adhesion and Adhesives), **19** (2), 45 (1983) (in Japanese)

Plate bending fatigue tests were applied on the glue-line of Buna (*Fagus crenata*)—epoxy resin adhesive joint system under wet condition. The results are:

- 1) Fatigue strength of the joints decreased with increasing polysulfide (flexibilizer) content mixed with the resin.
- 2) Fatigue strength of the joints increased with increasing thickness of the glue line, which is opposite to that in dry condition.
- 3) Fatigue strength of wet specimens was, in general, lower than that of air-dried specimens.
- 4) The ratios of the fatigue limit to the static strength in wet specimen vary from 0.33 (no flexibilizer) to 0.23 (60 part of flexibilizer mixed per 100 of epoxy resin).

S. ISHIHARA: **Actions of Phosphorous Compounds on Fire-Retardancy of Wood**, Mokuzai Hozon (Wood Preservation), **No. 23**, 40 (1983) (in Japanese)

A review is given combustions of wood and its controls, phosphorous and their compounds as flame retardant, controls of glowing combustion, N-P synergism and P-halogen synergism.

S.P. TAKINO and H. SASAKI: **Stiffness Performance of Prefabricated Wood-Framed Panels for Interior of Concrete Apartments**, Wood Research and Technical Notes, No. 17, 206 (1983) (in Japanese)

We have been co-worked with Japan Housing and Components Manufacturers Co-operative since 1977, testing stiffness performance of prefabricated wood-framed panels for interior. The tested data mainly concerning stiffness performance of floor panels and wall panels are collected in this report.

S. ISHIHARA: **Flammability of Wood and Fire Endurance of Wood Products**, New Lumberman, 13 (47), 1 (1983) (in Japanese)

Ignition, combustion, and char formation of wood, flame spread and burn through of wood products, and timber fire endurance are reviewed.

H. SASAKI: **Fracture**, in "Mokuzai no Jiten", ed. by I. Asano, pp. 178-185, Asakura (1982) (in Japanese)

A textbook on fracture of wood and wood glue joints covers configurations of wood micro structure, yielding conditions, crack propagation in wood and glue-line based on the fracture mechanics conception and time-dependent behavior of fracture in wood.

S. ISHIHARA: **Behavior of Wood Products in Fire and Their Controls**, in "Mokuzaihozongaku", ed. by Japan Wood Preserving Association, pp. 289-365, Bunkyo-shuppan (1982) (in Japanese)

A textbook focuses on general aspects of pyrolysis and combustions of wood, behavior of wood products in fire and their controls, fire retardancy and fire resistance of wood products, behavior of wood structures and components in fire. Chemistry and uses of fire retardants, treating processes, performances of fire-retardant wood products treated with chemicals, and list of fire retardants and their formulations are included.

K. NISHIMOTO: **Wood Preservatives**, in "Mokuzaihozongaku", ed. by Japan Wood Preserving Association, pp. 1-20, 111-186, Bunkyo-shuppan (1982) (in Japanese)

A textbook on chemicals involved in wood preservation covers lists of fungicides, insecticides and termiticides with their chemical and toxicological properties. Testing methods, treating process and other articles relating to wood preservation are included together.

K. NISHIMOTO: **Present and Future Status of Insecticides for Termite Control**, Shiroari, No. 7, 1 (1982) (in Japanese)

Chlordane, which has been exclusively used for termite control in Japan, is giving rise to a big sensation from a point of environmental pollution and toxicity, and that necessitates the development of new termiticides. Some alternatives are discussed

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briefly introducing that a lot of effort has been made to satisfy the requirements as termiticides.

K. NISHIMOTO: **Recent Trends in the Research and Development of Preservative-treated Plywood and Insecticide-treated Plywood.** Wood Research and Technical Notes, No. 17, 60 (1983) (in Japanese)

Recent investigations, in which bioassays have been conducted for plywoods treated with preservatives and insecticides, are briefly described with referring to the importance and significance of treatment of plywoods.

Practically glue-additive treatment seems most convenient and a retention of 960 g/m<sup>3</sup> chlordane has proved effective against *Lyctus* bores in a bioassay. A few organophosphor compounds are considered to be potential alternatives for the chemical. Phoxim and fentriothion have given promising results which protect timber completely from *Lyctus* attacks at retentions of 500 g/m<sup>3</sup> and 400 g/m<sup>3</sup> respectively.

Fungicidal effectiveness of glue-additive treatments of plywoods has been largely discussed in the laboratory so far. Among the preservatives tested, organoiodine compounds seem to have potential for this treatment, though a lot of study is still needed to apply these actually.

K. TSUNODA and K. NISHIMOTO: **Laboratory Method for Evaluating the Effectiveness of Fungicides in Controlling Sapstain and Mold on Wood,** Mokuzai Gakkaishi, 29, 481 (1983)

Several laboratory methods have been employed to estimate the efficacy of chemicals for preventing the growth of sapstain fungi and molds on wood. In many cases, the required minimum strengths of the chemicals, which are determined by the methods, are rather higher than those used practically at the timber yards.

Therefore, a newly designed testing method was developed to make it easy to compare the effectiveness of various anti-sapstain chemicals and to moderate the severity of the test conditions for a closer relationship between laboratory and field tests.

Two pairs of untreated and treated sapwood specimens (*Pinus densiflora* SIEB. and ZUCC., 40(L) × 20(R) × 5(T) mm) were placed on a water-saturated polyurethane sponge-mat in a Petri dish with a sponge inoculum fitted into the center hole of the sponge mat. A half set of the specimens was transferred onto a dry sponge-mat (dry condition) four days later while the other half was kept continuously under the wet condition. Visual estimations were made at regular intervals of seven days during the four-week test-period.

Commercial TCP (2,4,6-trichlorophenol 29%; organotin compound 2%) was not effective at any concentration level (0.31–1.55% a.i.). Amendment of TCP with

organoiodine compound definitely contributed to an increase in effectiveness, and a satisfactory performance was obtained at a 1.4% a.i. level under both wet and dry conditions.

The method is worthy of consideration as a screening test for the comparison of the effectiveness of various chemicals. In addition, the method under dry conditions might simulate the practical field-condition based on the mode of fungal infection, although further investigations on other chemicals are needed to determine the relationship between laboratory and field tests.

**K. TSUNODA and K. NISHIMOTO: Studies on Low Toxicity Anti-Sapstain Chemicals (2) Evaluation of the New Formulation as an Anti-Sapstain and Anti-Mold Agent, J. Antibact. Antifung. Agent, 11 (3), 87 (1983)**

A new mixture of 4-chlorophenyl-3-iodopropagylformal and 2-(4-thiazolyl) benzimidazole (mixing ratio 3:1, 6% a.i. solubilized concentrate) was tested by the standardized Japan Wood Preserving Association (JWPA) method and sponge method for its efficacy in controlling the growth of sapstain fungi and molds on wood.

A visual estimation of the fungal growth on treated wood specimens in both tests indicated that the mixture was superior in performance to chlorinated phenols such as pentachlorophenol and trichlorophenol (TCP) tested additionally for comparison. The mixture was proven to be effective at 0.03–0.06% in JWPA and sponge tests, whereas TCP did not seem to be satisfactory even at 1.50%. Therefore, the mixture could be an alternative to TCP-based products, which are in current use for the prevention of sapstain and mold on wood in Japan, in not only performance but also cost judging from the results obtained in this investigation.

**K. TSUNODA and K. NISHIMOTO: Fungicidal and Termiticidal Effectiveness of Alkylammonium Compounds, The Int. Res. Group on Wood Pres., Document No. IRG/WP/3232 (1983)**

Nine alkylammonium compounds were tested for their fungicidal efficacy according to JIS A 9302 (1976). At a retention level of 4 kg/m<sup>3</sup>, alkyl dimethyl and alkyl trimethyl types were as effective against *Coriolus versicolor* (L. ex Fr.) and *Tyromyces palustris* (BERK. ex CURR.) as CCA (Celcure K33). Higher retentions were generally required to control decay by *T. palustris*. The most effective chemical was didecyl dimethyl ammonium chloride with threshold values of 1–2 kg/m<sup>3</sup> and 2–4 kg/m<sup>3</sup> against *C. versicolor* and *T. palustris* respectively.

Termite tests were conducted for AAC-treated pine wood blocks with *Coptotermes formosanus* Shiraki, basically following JWPA Standard-11 (1981). At 2 kg/m<sup>3</sup> retention, all the treated pine blocks showed a slight deterrent effect on termite attacks, giving less 1.5% mass loss of the blocks.

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K. TSUNODA, M. TAKAHASHI and K. NISHIMOTO: **Studies on Low Toxicity Anit-Sapstain Chemicals (1) Chemical Control to Prevent Sapstain and Mold on Rubber Wood**, Wood Research and Technical Notes, No. 17, 122 (1983) (in Japanese)

Rubber wood is a potential substitute of currently used commercial timbers as as the trees grow fast and are felled every 20–30 years for replanting due to the decrease in latex yield. However, a major problem in rubber wood utilization is concerned with its poor resistance against insect and fungal attacks. If the problem is led to resolution, the extensive development could be promising in the near future.

Deterioration of rubber wood after felling is initiated by microorganisms such as sap-staining fungi and molds. It is, therefore, essential to prevent their invasion for obtaining stain-free rubber wood materials in wood industries.

The present investigation is related to the isolation of fungi and to the evaluation of effectiveness of some chemicals and mixtures in controlling fungal growth in the laboratory.

Isolation of sap-staining fungi, molds and basidiomycetes from fungus-infected rubber logs showed the heavy infestation of *Botryodiplodia theobromae* PAT., a typical blue-staining fungus, and a few species of mold. The isolated *B. theobromae* and three other fungi were served to the next experiment of which various chemicals and mixtures were tested for their effectiveness in controlling fungal growth on the treated sapwoos specimens of rubber wood (*Hevea brasiliensis* MUELL.-ARG.) placed on the nutrient agar medium in Petri dishes. Wood specimens, measuring 4 (T) × 4 (L) × 0.045 (R) cm, were dipped in treating solutions for 30 seconds and then air-dried. Each of the treated specimens was placed in a Petri dish with spore suspension of a test fungus. Visual evaluation was made every once a week for 4 weeks at 26±2°C.

Among the tested chemicals and mixtures, a mixture of 4-chlorophenyl-3-iodopropagylformal and 2-(4-thiazolyl) benzimidazole (mixing ratio 3:1) was superior to others in effectiveness. At 2% treating level, the growth of all the test fungi was completely inhibited, whereas tributyltin oxide, trichlorophenol and benomyl [1-(butyl-carbamoyl)-2-benzimidazole carbamic acid, methyl ester] failed to prevent fungal growth on the wood specimens at the same level. The results seem to expect that the mixture becomes an alternative low toxicity anti-sapstain agent instead of world-wide commercial trichlorophenol and pentachlorophenol.

R. IWATA and K. NISHIMOTO: **Studies on the Autecology of *Lyctus brunneus* (STEPHENS). V. Artificial Diets in Relationship to Beetle Supply**, Mokuzai Gakkaishi, **29**, 336 (1983)

In the mass culture of the *Lyctus* powder-post beetle (*Lyctus brunneus* (STEPHENS);

Lyctidae; Coleoptera) for a supply for control tests, the number of the progeny and their weights and body-lengths vary considerably according to the composition of their artificial diets. A general investigation on this point, however, has never been conducted, allowing a diversity of compositions used practically for culture and test purposes. Therefore, a series of new effective artificial diets, as well as the conventional ones, was investigated and compared.

The shortest duration of one generation hardly varied among the effective diets under constant conditions of temperature and relative humidity. The progeny number varied considerably among the diets, while the sex ratio for every diet was near 1:1. The progeny body-length, as a parameter of the degree of development, varied among the diets as well as between the sexes.

Two groups of the better diets were selected, one with regard to the progeny number and the other, the progeny body-length. Within these two groups a common diet was selected as a standard artificial diet: lauan sawdust (or cellulose powder) 26%, soluble starch 50%, brewer's yeast powder 24%. This proved effective as a standard artificial diet for mass culture, a prerequisite for *Lyctus* control testing. The results of rearing with it were satisfactory.

E. ENOKI and M. TAKAHASHI: **Metabolism of Lignin-Related Compounds by Various Wood-Decomposing Fungi**, Recent Advances in Lignin Biodegradation Research, pp. 119–133, Uni Publishers (1983)

The metabolism of lignin dimeric model compounds by various wood-decomposing fungi was investigated using low nitrogen media as described by KIRK *et al.* Three dimers with different types of linkage, 4-ethoxy-3-methoxyphenylglycerol- $\beta$ -guaiacyl ether (I), 1-(3',4'-diethoxyphenyl)-1,3-dihydroxy-2-(4''-methoxyphenyl) propane (II) and dihydroanisoin (III), were used. Twenty-nine species of Basidiomycotina (16 spp. of white-rot fungi and 13 spp. of brown-rot fungi) and three species of Ascomycotina were examined for their ability to degrade these dimers, most under stationary liquid culture condition, and, in some cases, in agar plate cultures. All three dimers were degraded at various rates by all of the white-rot Basidiomycotina and the Ascomycotina *Xylaria polymorpha*. Most brown-rot fungi and the other Ascomycotina could degrade dimer III but not dimers I and II. Only three brown-rot species degraded dimer I in stationary liquid cultures: *Gloeophyllum trabeum*, *Lentinus lepideus* and *Serpula lacrymans*. Only *S. lacrymans* and *Laetiporus sulphureus* could degrade dimer II. Identification of metabolites allowed metabolic pathways to be suggested in these brown-rot species; the pathways differed from that in white-rot fungus *Phanerochaete chrysosporium*. Although *G. trabeum* failed to degrade dimers II and III in stationary liquid culture, it showed activity against all dimers in agar plates. Such enhanced activity was demon-

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strated also in some white-rot species. Therefore, agar plate culture also should be used for investigations of lignin biodegradation. Differing abilities in degrading dimers I and II was suggested as a physiological basis for distinguishing most brown-rot and white-rot fungi. However, the fact that distinct degrading ability for the dimers I and II exists in a few brown-rot species is of interest when it is considered in relation to the biochemical evolution of the wood-attacking systems in fungi.

Y. IMAMURA, H. WADA, M. NORIMOTO and S. HAYASHI: **The Anatomical Characteristics of Softwood Bent by Utilizing Microwave Heating**, *Mokuzai Gakkaishi*, **28**, 743 (1982) (in Japanese)

Scanning electron microscopic techniques were employed to examine the anatomical characteristics of some softwoods that were bent by microwave heating. Deformation of tracheids was evident on the marginal tension side in cross sections. Anatomical changes of the tracheid walls on the compression side were varied with the radius of curvature of a bend and the susceptibility of wood species to microwave bending. Slight wall thickenings generally were observed on the inner surfaces of the tracheid walls near the neutral axis, crossing the microfibril orientation of the S<sub>2</sub> wall layer. Helical thickenings, which were considered to be remarkable features of woods bent with microwave irradiation, increased in both number and width toward the more compressed portions. In addition, the tracheid walls themselves were deformed wavyly near the concave face of a bend. The distribution of deformation was much wider and evenier in the tracheid walls compared with so-called compression failures commonly formed near ray-crossing areas and at the ends of tracheids. Wavy deformations and large helical thickenings disappeared when moistened with water, leaving only small thickenings. Based on the microscopic observations, it is concluded that the softening of wood-matrix substances by microwave heating results in the easy bending of wood specimens.

Y. IMAMURA, M. NORIMOTO and S. HAYASHI: **Cell Wall Deformation in Wood Bending by Microwave Heating**, *Wood Research and Technical Notes*, No. 17, 268 (1983) (in Japanese)

Anatomical characteristics of cell wall deformation of softwood and hardwood bends were examined thoroughly corresponding to radius of curvature of bending by microwave irradiation and recovering by moisture absorption. In concave face of bending specimens, SEM observations revealed that the slight wall thickenings were firstly formed in the inner surfaces of the cell walls and subsequently increased in their number and width following finally by wavyly deformation of the cell walls themselves. The progressive features of cell wall deformation as decreasing of radius of curvature were exactly equivalent to those found in the inner part of an ultimately



bent specimen from the neutral axis to the concave face. The cell walls in recovery process showed the reversal behavior of those in bending, leaving only the slight wall thickenings which were assumed to be the minute bucklings of cell wall components. Though deformation varied with radius of curvature as well as specific susceptibility to bending, a hardwood bend showed more complicated features than softwood one because of different types of longitudinal elements and large ray cells.